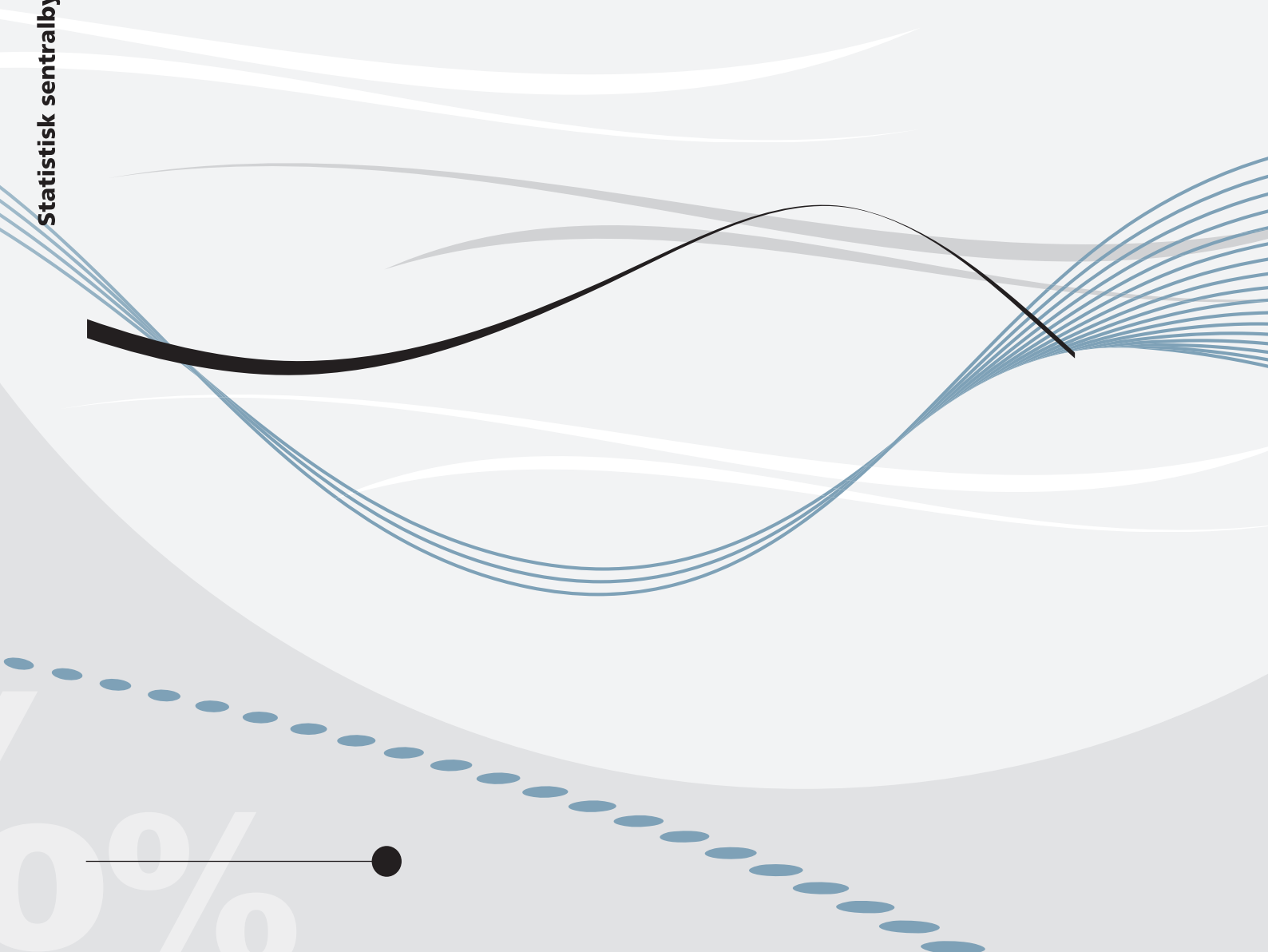


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**Imputing consumption from
Norwegian income and wealth
registry data**



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Abstract:

Data on consumption expenditure of the household is essential in a wide array of economic research. This includes both topics in micro as well as macroeconomics. However, obtaining a consistent and precise measure of household consumption has proven notoriously difficult. This paper documents a method for computing a longitudinal consumption measure for Norwegian households from administrative records of income and wealth. Expenditure surveys tend to suffer from limited sample sizes and underrepresentation of high-income households. Administrative data does not have such limitations and offers a much larger sample with better coverage of all household types. This is particularly useful for improving the measurement of heterogeneity in consumption behavior.

Keywords: consumption measurement, savings, household finance

JEL classification: D12, D14, D31, E21, G11

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Sammendrag

Detaljerte data om husholdningers konsumentatferd er viktig for analyse av mange spørsmål innen økonomisk forskning og også for mange politikkmakere. Husholdningens konsum har tradisjonelt sett blitt målt ved hjelp av forbruksundersøkelser, utført på et lite utvalg av befolkningen. I dette notatet dokumenterer og gjennomfører vi en alternativ metode for å måle (imputere) konsumet for hele den norske befolkningen, ved hjelp av administrative data for inntekt og formue, for en periode over nesten 20 år, fra 1994 til 2011. Ved bruk av årlige og detaljerte data om husholdningenes inntekter og formuesposter fra selvangivelsen utleder vi først husholdningens sparing (som den aktive endringen i husholdningens formue fra ett år til et annet), og deretter konsumet gjennom året som den delen av inntekten som ikke spares. Bredden i datagrunnlaget gjør dataene attraktive for studier av heterogenitet i forbruksmønstre, og fordelingsanalyser. I tillegg muliggjøres mange analyser relatert for eksempel til husholdningers respons til inntektsusikkerhet og arbeidsledighet, samt til endringer i økonomiske forhold som boligpriser og renter.

1 Introduction

Data on consumption expenditure of the household is essential in a wide array of economic research. This includes both topics in micro as well as macro economics (Pistaferri, 2015). However, obtaining a good measure of household consumption has proven notoriously difficult. This paper proposes a method for computing a unique longitudinal consumption measure for the total population of Norwegian households from administrative records, covering a period of almost 20 years.

Traditionally, obtaining a measure of household consumption has been achieved through budget surveys. However, these surveys are costly, both for the collector and the individuals, and the quality of the data often does not meet the needs of the user (researchers, economists). Between 1975 and 2010 Statistics Norway conducted annual consumer expenditure surveys analogue to those of many other countries (such as the CES in the US and the FES of United Kingdom). However, there has been a general deterioration in survey response rates in Norway, as in many other countries. The consumer expenditure survey in Norway was terminated in 2009, and is now conducted less frequently (Holmøy and Lillegård, 2014). In addition, expenditure surveys have other known drawbacks such as recall error for durables and other infrequent expenditures, attrition, under representation of wealthy families, and under reporting of spending (Carroll et al. 2014). Despite the difficulty of obtaining this measure, the importance of having such a measure has not diminished, neither from the perspective of policy makers at the more macro level, nor economic research at the micro level. This has encouraged a recent literature on the measurement of household consumption expenditures that calls for improvement of the traditional expenditure surveys and alternative data sources for measuring consumption, see Browning et al. (2014), Carroll et al. (2014) and Pistaferri (2015).

One of the main new sources for measuring consumption has been imputation from administrative records of income and wealth information collected for tax purposes. Browning and Leth-Petersen (2003), Koijen et al. (2014) and Kreiner et al. (2014) impute consumption from Danish and Swedish administrative registries respectively.¹ They are further able to link their measures of imputed consumption at the household level with data on consumption expenditure at the household level, and they conclude that the imputation method is promising. However, with the abolishment of the wealth tax the Swedish panel ended in 2007, and hence lacks actuality.

The advantage of imputed consumption from registry data is that one may

¹Recently, Brinch et al. (2015) executes a similar exercise on Norwegian data. Their findings (referred to in Autor et al., 2015) are comparable to those here.

potentially have data for the entire population, although in practice some exclusion is necessary in order to obtain sensible measures of consumption. Our approach follows that of Browning and Leth-Petersen (2003), Koijen et al. (2014) and Kreiner et al. (2014), where the basic underlying imputation equation follows the simple accounting relation of the budget constraint

$$Y = C + S, \tag{1}$$

where income (Y) must be either consumed (C) or saved (S). Theoretically this relationship appears clean. However, when trying to disentangle consumption from the income and savings data a number of issues must be dealt with. In the following we discuss these issues and describe our imputation method.

Despite the computational difficulties and the fact that some exclusions are necessary (and one therefore does not end up with a full population coverage), the remaining coverage is nonetheless extensive compared to surveys. The large coverage of registry data is vital for improving the measurement of heterogeneity in consumption behavior. Another great advantage of imputed consumption from registry data is that it provides panel data, even covering very long time spans. This allows for consistent estimation in the presence of unobserved heterogeneity. These advantages make research based on long panels on household consumption expenditure data from administrative records likely to increase.²

Section 2 discusses some main concepts before Section 3 presents the framework for the imputation method. In Section 4 we examine how our imputed consumption measure is distributed over the life cycle, while Section 5 looks at the development of our consumption measure over time. Section 6 compares the imputed consumption data with available data from the Consumer Expenditures Survey, and discusses how one may exploit the richness of our imputed measures in distributional analysis. In Section 7 we provide more details on the data sources, details on the imputation method, a description of the sample restrictions imposed and the sensitivity of our measure to these restrictions. In addition, we provide some alternative definitions of consumption. Section 8 concludes.

2 Definitions of income, consumption and saving

Below we discuss the operationalization of some important concepts. The basic element of our method is to apply information on income and savings over time, which we

²A recent and important application is found in Browning et al. (2013), showing that the effect of changes in housing wealth on consumption in Denmark are negligible.

will discuss in detail. What to include in the consumption measures (e.g. durables) also requires clarification. Along the way we relate some of the conceptual difficulties to our main data source, the Norwegian tax registry. Detailed information about our data sources are presented in Section 7.

2.1 Income

Hicks's definition of income is the maximum amount that you can expect to consume without reducing net worth:

“... a person's income is what he can consume during the week and still expect to be as well off at the end of the week as he was at the beginning.” (p. 176, Hicks, 1946)

Hicks considered three *ex ante* definitions by specifying in different ways what exactly is meant by “consume” and “well-off”. As Hicks himself recognized, none of the three definitions have any precise *ex post* counterparts, once both labor and property are considered as sources of income. However, a forward looking measure of income is the appropriate one according to many economic models of consumption, rather than backward looking ones, as in Haig (1921) and Simons (1938). When the definition of income is an *ex ante* definition nothing is said about the realization of the expectation. The value of a person's income prospect at the end of the week may be greater or less than expected. In other words there may be “windfall” gains or losses. For risky assets we tend to get essentially unpredictable gains and losses, but also labor income may be risky due to e.g. unemployment and illness. *Ex post* measures of income is no equivalent to the theoretical income concept that is the basis for consumption decisions. However, if consumption is unaffected by “windfall income” then it is appropriate to include these incomes in the saving measure. In other words, a windfall gain during the week will not affect the consumption in the same week (since this was decided on at the beginning of the week), but it will affect the consumption possibilities in the next week. When the available data is tax records that contain information about all labor, transfer and financial income received in the course of a calendar year, the income measure will always include windfall gains. For example, any part of a lottery winning that is immediately invested in financial assets will be defined as savings, so that the income measure will only contain the part of the windfall that is not saved.

Another useful definition of income is the value of all resources that are freely disposable, during a definite period of time. This definition excludes illiquid gifts and unrealized capital gains and losses. A typical example of an asset gain that is

unrealized – in the short run – is house price appreciation. Definition of income based on tax records will not include unrealized capital gains and losses, but it will include realized capital gains and losses on stocks and housing at the time of realization even though the gain or loss could have been accumulated over time. Financial income, or capital income, includes interest expenditures on debt and mortgages, but for home-owners there is a gain from owning a property rather than renting the same property. However, this is an intangible income that needs to be imputed.

2.2 Consumption of durables

In economics, consumption is modeled from two sides. On one side, it is a flow of goods and services that yields utility to the household. On the other, it is an expenditure that must be paid for within the limitations of the budget constraint. Equating these two concepts of consumption is unproblematic as long as consumption is paid for in the same period that it yields utility. Once we allow for consumer goods to be durable, they may provide utility-yielding services over many years, and the tight temporal connection between expenditure and utility is broken. This situation is most striking in the case of housing, but it applies to all consumer durables.

Consumption may be divided according to the durability of the purchased objects. In this vein, a broad classification separates durable goods (as cars and television sets) from non-durable goods (as food) and services (as restaurant expenditure). A durable good yields utility over time and can thus be thought of as an investment good that depreciates over time (wears out). Theoretically, the annual depreciation should be included in a measure of annual consumption, while the remaining value should be part of the real asset measure. However, the division between durables and non-durables can be tricky and it is even more cumbersome to determine the longevity of each durable good.

In the case of durable goods, it is not theoretically appropriate to measure consumption by the expenditure of the item. Rather, consumption of durables should be referred to by the rental equivalent or the user cost. This could be defined as the opportunity cost of funds tied up in the durable good plus the depreciation of the good. The National Accounts' consumer expenditure measure includes all durables, such as cars, in the year of purchase - except housing. Real estate purchases are usually defined as investment in real assets. However, the National Accounts include imputed rent as part of the consumption measure.

2.3 Saving

There are two ways of defining saving that a priori should yield the same result: saving equal to income minus consumption and saving equal to the first difference in wealth. When treating saving as the residual of income minus consumption, the definition of saving would obviously depend on the choices made about windfall gains and losses in the income definition, and durables in the consumption definition. If the purchase of a durable good is considered as consumption in the year of purchase, it cannot be considered as an investment as well. In practice, using the flow definition of saving (income minus consumption) will depend heavily on the definition of income. If unrealized capital gains are not measured in the income variable, it is not in the measurement of saving either.

An alternative is to measure saving as the change in wealth. According to standard life cycle theory, utility is maximized under the following budget constraint:

$$NA_t = (1 + r)NA_{t-1} + Y_t - C_t$$

where NA is net worth (measured at the end of a period), Y is labor income after tax (including transfers), and C is consumption. This constraint can be re-arranged to give the alternative definition of saving

$$S_t = NA_t - NA_{t-1} = rNA_{t-1} + Y_t - C_t$$

In other words, saving is the change in net worth from the end of period $t - 1$ to the end of period t , which theoretically should be equal to the flow of income minus the flow of expenditures in period t .

The treatment of unrealized capital gains and losses is the main difference between the flow measure of saving and the stock measure of saving, and the two measures can differ substantially whenever there are large unrealized capital gains or capital losses on existing assets. Thus, one reason for focusing on the flow definition of saving is that it reflects individual decisions about how much to consume and how much to save more directly. Capital gains or losses make it difficult to tell whether households are consuming a higher, or lower, fraction of their income at different points in time. For example, a household could be actively saving out of their income, but because of a sudden drop in stock market value, the overall change in net worth would be negative. Using the accumulation of wealth as a measure of saving opens a whole new set of issues since it requires a correct measurement of all wealth items in the portfolio. In the stock definition, both realized and unrealized capital gains are included by default, as well as new investment and new liabilities.

In most wealth statistics it is difficult to separate change in volume from change in price.

One way of overcoming the problem is to estimate the gains that each household would have experienced on its portfolio (measured at the end of the previous period, $t - 1$) if it had risen in value at the average rate of increase, and then impute the active savings net of expected returns. Here, we will follow the method proposed by Kojien et al. (2014) where the known composition of the asset portfolio is used to impute the returns that the household are earning on their assets. In comparison, when imputing consumption based on the Danish data Kreiner et al. (2014) assume a common zero capital gains return on all assets. Kojien et al. (2014) find this is likely to underestimate consumption in periods of positive capital gains, and overestimate in periods of negative capital gains. Furthermore the measurement error is typically increasing in wealth.

In the flow measure of savings both income and consumption should be measured in real terms, and since consumption is in the equation it is straightforward to assume that the consumer price index can deflate the nominal values. It is worth noticing that in the stock measure of savings, inflation plays a role in itself. There is an asymmetry between assets and liabilities in the wealth portfolio. Many assets accrue nominal capital gains, of which one part is variation in the general price level and the other part is real capital gains. Liabilities on the other hand are set nominal values that decrease steadily in real value with inflation, what we can call an inflation gain.

3 Imputing consumption from register data

The data is derived from a combination of administrative registers covering all individuals in Norway, where the main data source used in the analysis is the register of tax returns that contains detailed information about all individuals' incomes and wealth. These data are of high quality because most information is third-part reported to the tax authorities, and very little is self-reported. The information from the tax returns is combined with family identifiers from the population register in order to aggregate all income and wealth information at the family level. Thus all variables in the analysis is measured at the family level.³ More details on the data sources and definitions are given in Section 7.

We combine information from Norwegian registry data on income, asset holdings, and asset returns to arrive at imputed consumption expenditure from the household

³A family is defined as either one or two adults plus any number of children.

budget constraint. This method will be comparable to and along the lines of the work done by Browning and Leth-Petersen (2003), later also applied and extended in Koijen et al. (2014), Kreiner et al. (2014) and Brinch et al. (2015). The household can use her resources which consists of cash-on-hand, $[Y_t + (A_{t-1} - D_{t-1})r_t]$, and the debt taken out $(D_t - D_{t-1})$ to finance consumption C_t , to invest in financial assets $(A_t - A_{t-1})$ and to invest in housing $(P_t^h I_t^h)$:

$$C_t = Y_t + (A_{t-1} - D_{t-1})r_t - (A_t - A_{t-1} + D_{t-1} - D_t + P_t^h I_t^h)$$

which gives us a definition of consumption of household i in period t is as total income minus savings. However, for reasons that will be explained more later we exclude periods with housing investment because of measurement errors. On the other hand we include any lottery winnings, inter vivos gifts and inheritances (B_t) that are available in the data, i.e.

$$C_t = Y_t + (A_{t-1} - D_{t-1})r_t + B_t - (A_t - A_{t-1} + D_{t-1} - D_t) \quad (2)$$

In our data, the change in nominal financial assets from one year to the next consists of two parts; changes in the stock of asset and changes in the valuation of the asset. We do not want unrealized changes in the asset's price, i.e. unrealized capital gains and losses, to be part of our consumption imputation as they do not reflect the household's active consumption and savings behavior. Thus what we call "active savings" is the nominal change in financial assets minus capital gains and losses. For stocks we have used the Oslo Stock Exchange index (OSE) to calculate gains and losses, for mutual funds we have used a combination of the OSE and the MSCI World index and for bond we have used the Treasury bill rate. For more details on the calculations we refer to Section 7.2. Equation 2 also provides the definition of disposable income used throughout this analysis as labor income + transfers + net capital income, all measured after tax, plus any lottery winnings, inter vivos gifts and inheritances.

The consumption and savings measure derived from first differences in taxable wealth presents one serious measurement error. While all debt secured by housing wealth is measured in full, its counterpart, the housing value is not. The reported tax values for housing had a weak relation to actual market values before 2010. Even though imputed measures of housing values were implemented in the tax return from 2010, these values are also imprecise with respect to the actual market value of each individual dwelling. This asymmetry is most problematic for remortgaging in connection with house transactions, but also prevalent when households purchase

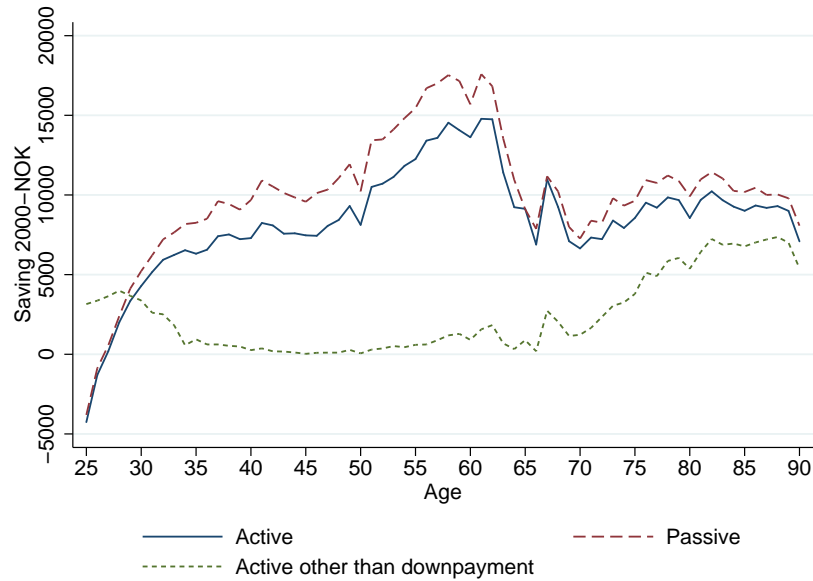
summer homes or during financial reshuffling in the process of a divorce. As a consequence, we have imposed a restriction that ensures that we only consider “stable” periods, thus excluding single years of housing transactions, holiday home transactions, or periods in which couples move in together or split up. The tax returns have no direct information about such events, but some may be deduced from changes in address, transitions of existence/non-existence of tax values, and changes in number of adults in the household. Obviously, such information is not always correct with respect to timing and even when applying exclusions based on this information we are still left with a sizable measurement error problem. Needless to say, the restriction to stable periods limits the researches ability to study these important life events, but we leave it for future research to obtain reliable measures of consumption also during these phases.

In addition, there are two other measurement error problems: large movements in unlisted stock wealth among the wealthy, and very low levels income after tax. The latter is a measurement problem if it represents unreported incomes or timing issues that causes a misrepresentation of annual income. Large movements in unlisted stock wealth among the wealthy are more a source of noise in the data, but in years before and after the tax reform of 2006 it is also a systematic problem as the wealthy were adjusting income and wealth to avoid the introduction of a tax on dividends. It is hard to justify such behavior as true measures of consumption and saving. Section 7.5 presents in more detail the conditions for sample selection and the consequences in terms of sample size and representation.

4 Saving and consumption over the life cycle

Consumption tracks income closely over the life cycle. This property follows from the way consumption is imputed, i.e. as income minus active savings. Hence it is really the savings behavior over the life cycle that is of most interest. Figure 1 shows the effect of separating active and passive savings. Passive saving refers to the overall change in net wealth without changes in housing wealth. Passive saving including house price gains would result in an inverted U-shape profile that peaks at an absolute level that is more than four times the top level in Figure 1. Passive savings without housing gains follows mainly the same pattern as active saving, and in line with traditional life cycle theory; negative savings in younger years, then a gradual increase in savings until it peaks at ages 55-60, thereafter active saving drops markedly at retirement. The lowest line the Figure 1 shows how the main savings vehicle is down payment of debt. Active saving other than accrual or down payment of debt is small at the median, except for young households saving up for

Figure 1. Median active and passive saving by age



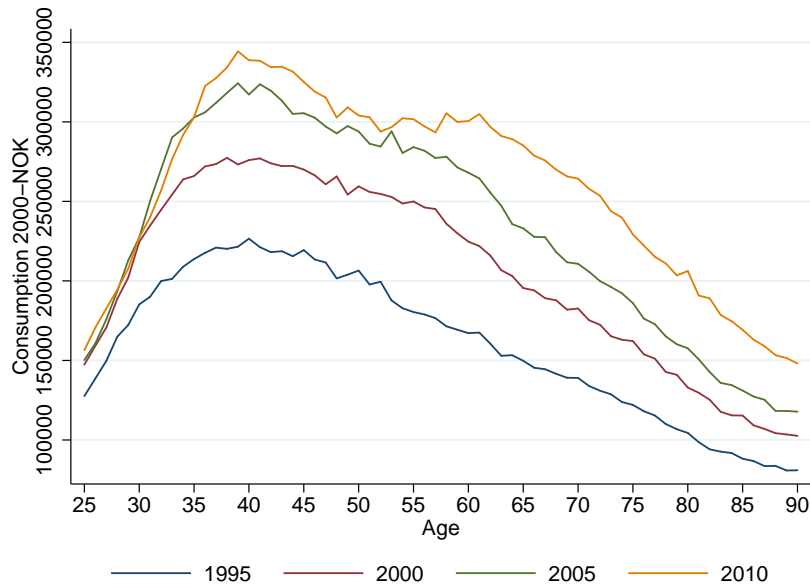
Note: The figures plots three definitions of savings (active, passive and active savings other than down payment of debt) by age pooling the cross-sections 2005-2011.

house purchases and elderly households.

In the savings figure we have pooled the years 2005-2011 since the variation in savings measured at each single age-year combination is sizable and because there is no clear difference in levels of the saving-age profile over time. Consumption is another matter, and Figure 2 shows cross sections of the consumption-age profile for selected years. These plots reveal a distinct life-cycle pattern, and a large increase in real consumption over time. All values are net of inflation, so this represents a real increase in consumption over our sample period. From 1995 to 2005 the mean consumption for a household with a 40 year old male head increases in real terms from NOK 200,000 to almost NOK 350,000, an increase of NOK 150,000 or around USD 22,000.⁴ The effect of the financial crisis is clearly visible as a dent in the life cycle profile for 50- to 60-year-olds in 2010. The difficulty with cross sectional representations of consumption over the life cycle is that in the presence of generational differences, it is impossible to determine whether cross section evidence provide a corresponding pattern for the life cycle or whether it is the result of observing different generations at different points in time. As would be expected from simple life cycle theory, the main factor determining such cohort effects has been differences in productivity growth in the lifetimes of cohorts that would affect

⁴During our sample period (1993-2011) the average USD/NOK rate was around 6.9. All values reported in NOK are (if not otherwise noted) deflated by CPI (with base year 2000).

Figure 2. Median consumption by cross sections



Note: The figures plots the median consumption at observed age for selected cross sections, 1995, 2000, 2005 and 2010.

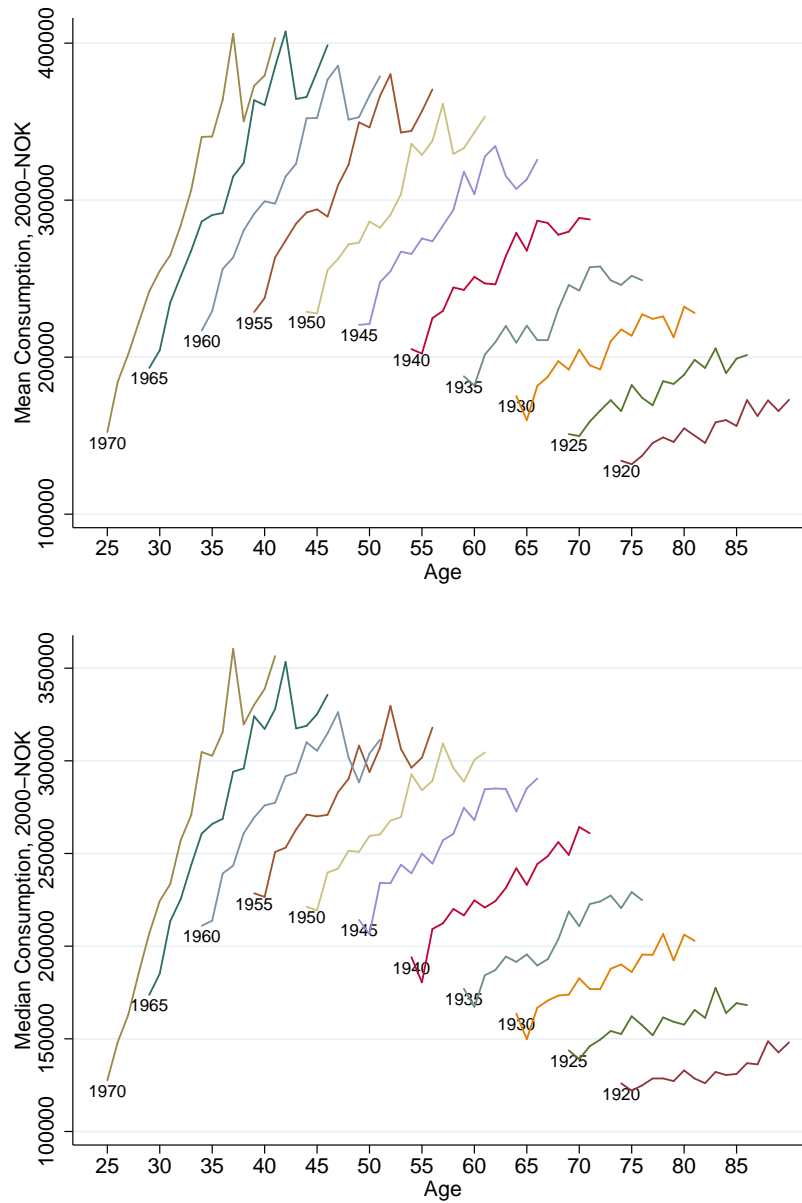
their income histories.

Therefore, we present an alternative representation in Figure 3, where we follow selected birth cohorts over time and consequently also by age (both mean and median consumption). Here, we note that the consumption growth over age is considerably steeper than what we would infer from the cross sectional graphs alone. The patterns still reveal a hump shape over the life cycle, and year effects are visible as the sawlike development over age for each cohort.

What the figures above have illustrated is that there are real consumption growth effects over time that causes younger cohort to follow life cycle consumption profiles at a higher level than previous cohorts. They also show that macroeconomic events, such as the financial crisis can affect different ages or cohorts differently. In this case it was a shock that affected middle-aged households more than elderly households. Ideally, we would like to present a “pure” consumption age-profile that is adjusted for period and cohort effects. Age effects relate to the process of aging. Period effects contain macroeconomic events that affect all persons such as business cycle effects, periods of growth, and policy changes. Birth cohort effects are a combination of the two above, i.e. it relates to experiencing a specific event at a specific time, for example when experiences in early life influence behavior over the remaining lifetime. In fact, any of the three effects may be seen as a combination of the other two.

Therefore it is also a statistical problem to separate the age, period and cohort

Figure 3. Mean and median consumption by cohorts over the life cycle



Note: The figures plots the mean (top) and median (bottom) consumption at observed age for selected cohorts over the period 1994-2011.

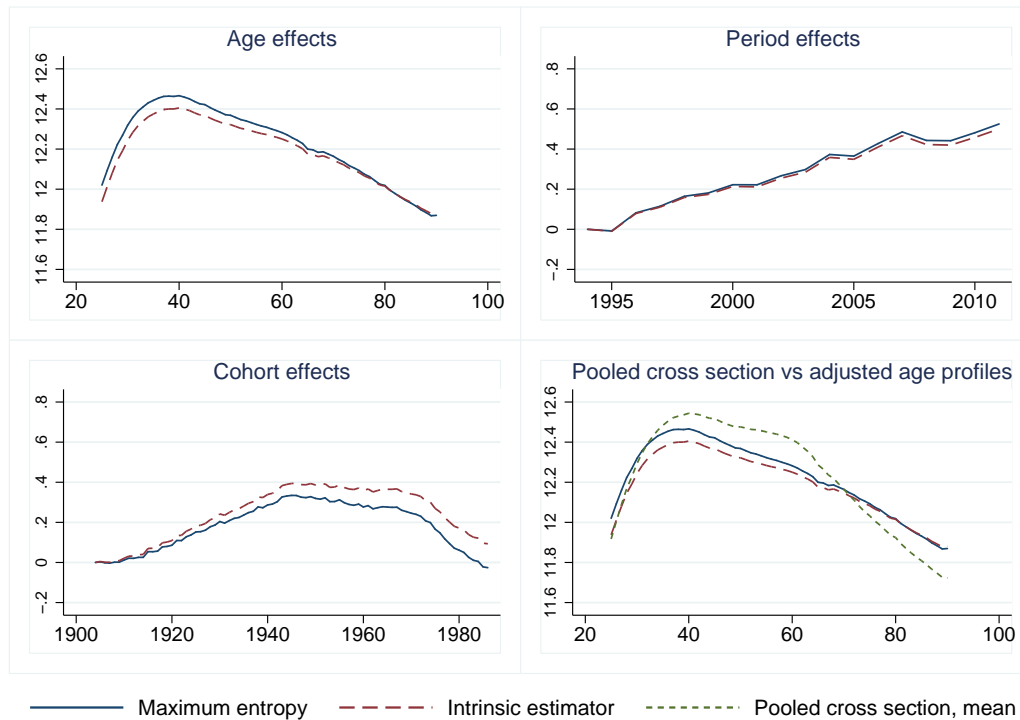
effects. This identification problem has been a point of methodological controversy for decades, with little agreement on a systematic set of interrelated models and methods for analysis. While there may be an infinite number of solutions to the equation, if models are constrained in a certain way, one can make sure only one solution is found. In the past 40 years there have been many technical papers which suggesting ways to constrain the solution, and by that at least try to minimize the identification problem. We will not refer to all of them here, but limit ourselves to two approaches. Yang et al. (2008) and Fu et al. (2011) suggest the use of the “intrinsic estimator” (IE), while Browning et al. (2012) propose using the maximum entropy principle to formalize the uncertainty rather than trying to solve the point identification problem directly. None of these methods will solve the identification problem (as it is unsolvable); one must rely on choosing a method that provides estimates of the effect coefficients that seem reasonable.⁵ However, both Browning et al. (2012) and Yang et al. (2008) have demonstrated that alternative methods for restraining parameters may lead to wildly differing coefficients depending on which two parameters that are chosen, and that both the ME and the IE generally outperforms constrained parameters in terms of credible effects.

In Figure 4 we show the result of employing the two methods for decomposing age, period and cohort effects. The two decomposition methods yield slightly different estimates for the three effects, thus illustrating nicely how the identification problem works. If one effect is estimated to be at a higher level, the other two must be lower. Despite the small differences in level, it is reassuring that the overall pattern survives in both specifications. The period effect in Table 4 conforms the overall real growth in consumption over time with a visible decline during the financial crisis. The cohort effects are estimated to be largest for the baby boom generations (those born in 1945-1955). When controlling for cohort effects, i.e. high consumption of baby boom generations and low consumption in older cohorts, the consumption-age profile is flatter than what we would obtain by plotting the consumption-age profile based on pooled cross sections.

Contributions by Blundell et al (1994), Attanasio and Browning (1995) and Attanasio et al (1999) emphasize the importance of household size for explaining a large part of the hump in consumption over the life cycle. In the basic version of the life cycle model the optimal consumption is usually related to marginal utilities over time and not expenditures per se, and changes in household size over the life

⁵Alternatively we could have used a semi nonparametric regression like Fernández-Villaverde and Krueger (2007), i.e. combination of a parametric part that includes period and cohort dummies and a non-parametric representation of age. Although intuitively appealing, not even this method solves the identification problem.

Figure 4. Decomposition of age, period and cohort effects in household consumption

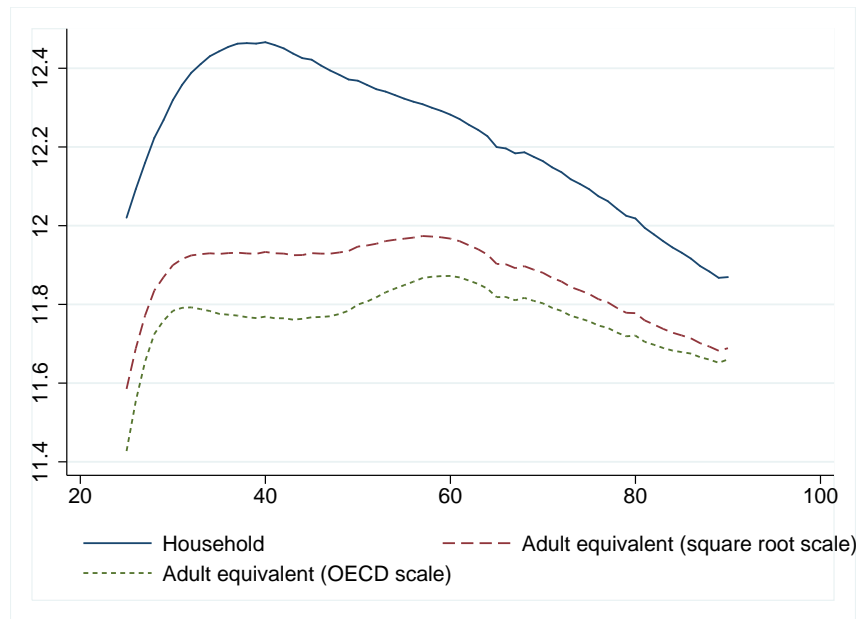


Note: The figures displays the age, period and cohort profiles of log consumption when applying respectively the maximum entropy principle (Browning et al., 2012) and the intrinsic estimator (Yang et al., 2008; Fu, 2000) to the identification problem of separating age, period and cohort effects. Lastly, in the lower-right figure, we plot the two age profiles in the upper-left figure to the average age profile when pooling the cross sections in our data, 1994-2011.

cycle may change the household’s marginal utility. As argued by Fernandez (2007), in order to compare model based predictions to their empirical counterparts, one should ideally control for period effects, cohort effects *and* demographics.

We have calculated the demographics-adjusted age profile using equivalence scales. Since the OECD-scale assumes relatively little economy of scale, we also present the demographics-adjusted age profile based on the square root scale. In both cases we control for period and cohort effects using the maximum entropy method. Changes in household size seem to account for a sizable part of the hump in consumption around age 40, as Figure 5 shows that the adult equivalence consumption-age profiles are flatter between age 30 and age 60 than the corresponding profile for household consumption. Fernandez also find that the peak in consumption moves towards older households after controlling for demographics, although not quite as pronounced as in Figure 5.

Figure 5. Consumption age profile controlling for period, cohort and demographics



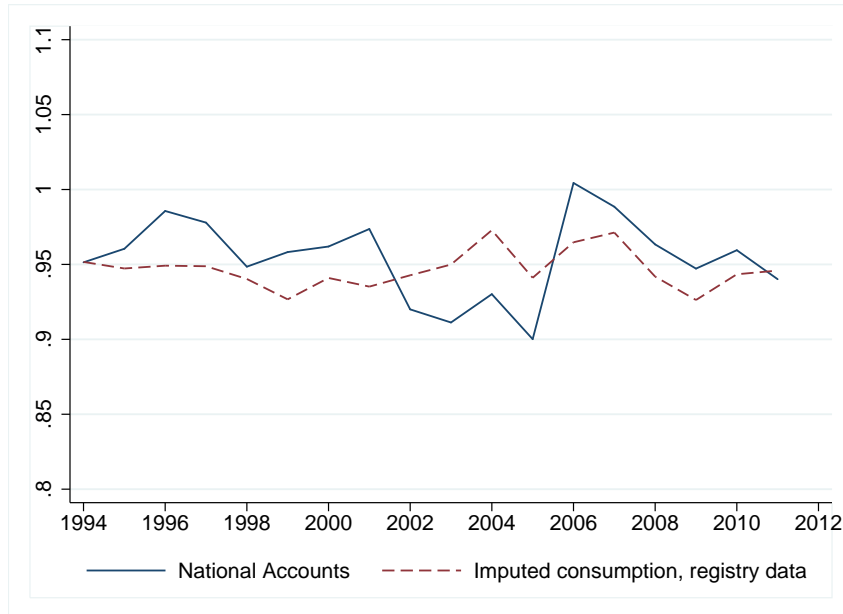
Note: The figures displays the age profiles of log consumption when applying the maximum entropy principle (Browning et al., 2012) using three definitions of consumption; aggregate consumption at the household level, adult equivalent household consumption, using a square root scale (scaling by the square root of the number of household members), and adult equivalent household consumption, using the OECD scale (assigning the value 1 to the first household member, 0.7 to each additional adult and 0.5 to each child).

5 Saving and consumption over time

Figure 6 shows median consumption rates over the period 1994-2011. The consumption rates from the registry data are measured as fractions of disposable income, in order to make them comparable to the National Accounts' definition of income. By construction the National Accounts' consumption rate and saving rates simply mirror each other. Since the imputed consumption is derived as income minus saving, so do the registry series.

We note that the National Accounts' consumption rate is affected by developments in top incomes over time. For instance the income shifting due to the tax reform in 2006 causes a distinct variation in the consumption and savings rates in the macro economy. Under the Norwegian 2006 tax reform, dividends became taxed at both the corporate and individual levels. The introduction of a tax on dividends caused major income shifting in the years prior to 2006 as discussed in more detail by Alstadsæter and Fjærli (2009). Dividends were paid out in the years prior to 2006, causing consumption as a fraction of income to drop, while saving rates increased

Figure 6. Consumption rates over time



Note: The figure displays consumption rates (measured as the fraction of consumption to disposable income) from National accounts and from registry data (median rates) over the period 1994-2011.

as the dividends were shifted into assets instead. In 2006, consumption rates in the National Accounts were unusually high simply because there were virtually no dividends in the income account. There was also a temporary tax on dividends in 2001 that caused the same kind of response, but at a much smaller scale.

In Norway, the ten percent wealthiest own 49.5 percent of total net wealth, and the top three deciles of the income distribution receives almost half of total income after tax (according to Statistics Norway's income and wealth statistics for 2013).⁶ The behavior of the wealthy households may have a large impact on aggregate measures but their behavior is not necessarily described by a general lifecycle model, see Carroll (2000).

In order to avoid developments in the data due to tax avoidance behavior such as witnessed prior to the 2006 tax reform, we have chosen to exclude large dividend payouts from our consumption measure (where large is defined as greater than 1G, i.e. the basic amount in the National Insurance scheme).⁷ Furthermore, because of measurement errors we also exclude owners of unlisted stocks, see Section 7.5. The consumption and saving rates derived from the registry data is therefore not equally affected by the richest households. Instead, the registry data reflect more the effects

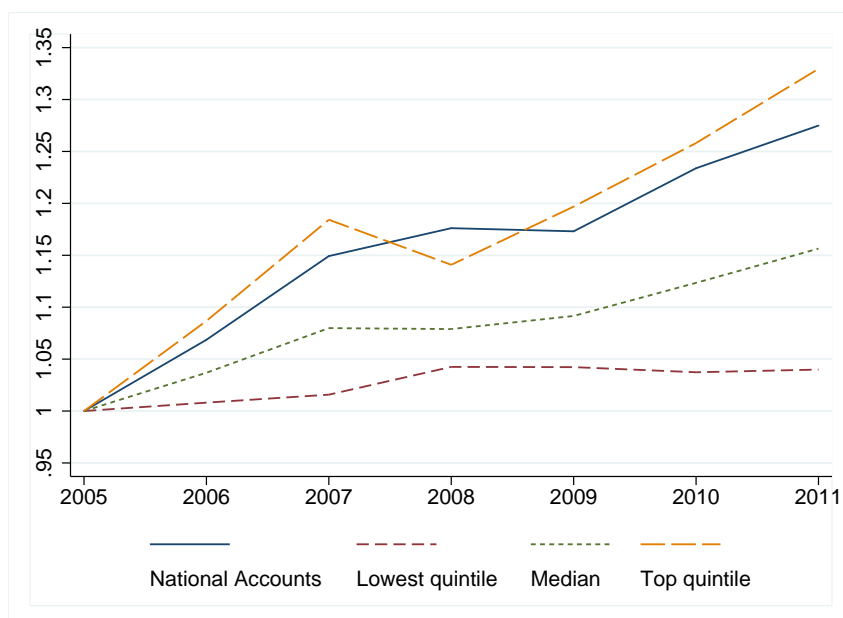
⁶See <https://www.ssb.no/inntekt-og-forbruk/statistikker/ifhus/aar/2014-12-17>

⁷The tax regulations contain a number of amounts and amount limits which are directly linked to the basic amount in the National Insurance scheme, often written as 'G'.

of credit growth on consumption. For instance, after the currency crisis in Asia in 1998, the temporary slowdown in the economy resulted in a credit growth decrease in late 1998 that stayed low until the middle of 1999. This is visible in the registry rate of consumption as a drop in 1999, while periods of strong credit growth such as 2003-2004 and 2006-2007 displays peaks in the data series.

In 2008, a financial crisis hit the economy and caused a drop in consumption and an increase in saving. In the period 2007-2010 the development is parallel in the National Accounts data and the registry data suggesting that there were factors in the economy that affected both the sum of households and the median household equally in this period.

Figure 7. Accumulated consumption growth rates, National Accounts and imputed consumption by income quintiles



Note: Consumption index based on median growth rates of imputed consumption by quintiles of income after tax vs the National Accounts' index. 2005=1

In Figure 7 we show the growth in aggregate consumption as measured by the National Accounts⁸ compared to the distribution of growth rates in imputed consumption by income after tax quintiles. This figure suggests that the growth in consumption that the national aggregate displays up until 2007 greatly exaggerates the growth rates of the major part of the population. In the period 2006-2011 the macro-consumption growth rates are more in line with the top quintile of the income distribution than the rest of the distribution. It is clear from Figure 7 that the crisis immediately affected the consumption of the high-income households (although they

⁸See <https://www.ssb.no/nasjonalregnskap-og-konjunkturer/statistikker/nr>

recovered quickly).

One might be concerned that our method for reducing measurement errors in the consumption measure also leads to under-representation of high-income households. One of the advantages of using register data is that many individuals or households remain in the sample even after exclusions are made, and that it is possible to cross-check results with and without exclusions. Removing owners of non-listed stocks and households receiving extreme dividends removes only 28 percent of households in the top income decile in each year. As shown in Table 3, it lowers the mean of the top incomes (and thus mean consumption), but we gain more in robustness as it reduces the standard deviation our consumption measure considerably.

Even with selection there is concordance between the results in Figure 7 and those of Pistaferri (2015) on US data. Pistaferri finds that the consumption growth was higher in the top income quintile than in the bottom quintile before the crisis in 2008, and that their decline in growth rates was more pronounced during the crisis. He finds this puzzling since high-income households should be more able to smooth consumption across adverse shocks, but points to the explanation that high-income households experienced a wealth-destruction shock that required additional saving in order to restore their buffers. In Fagereng and Halvorsen (2015), we attribute some of the decline in consumption growth rates in high-income households to a revision of expectations, and postponement of investment in durables.

6 Consumption distribution and inequality

Expenditures measured from surveys are often less useful for distributional analysis of total consumer expenditure since they tend to under-represent high-income households and since sample sizes are small. Consumption imputed from registry data, covering the whole population, may offer new perspectives on distributional analysis. Here we present comparisons of our imputed consumption measures with the survey in 2000 and the 2005-2007 survey. The former survey had 1,048 respondents, the latter survey had 3,156 respondents (pooled over three years), and both were based on a stratified sample of the Norwegian population.

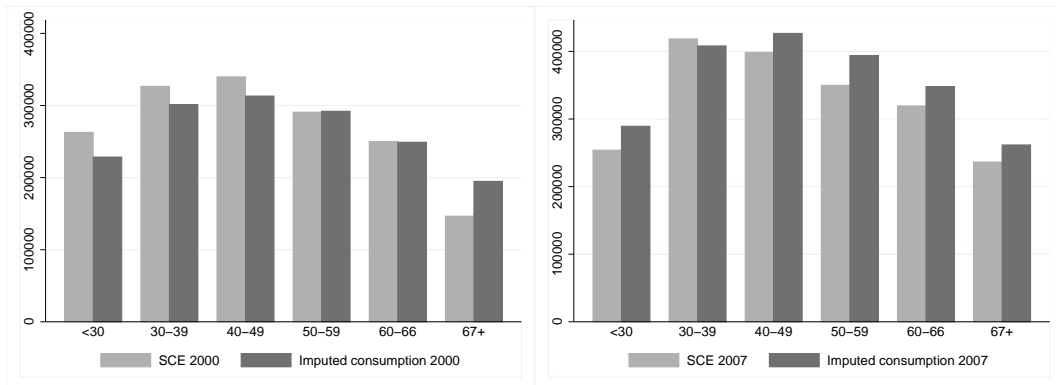
6.1 *Distribution*

The Norwegian Survey of Consumer Expenditures (SCE) is a survey based on two weeks of expenditure accounting, with additional interviews. The unit of observation is a household, defined as persons having a common dwelling and sharing at least one meal per day. Institutions are not included in the survey. The interviews collect

information on household characteristics, such as age and employment status of all members of the household, and expenditures that may not be properly covered by the two week accounting period such as durables and annual expenses. Thus total consumption expenditure is estimated as the payments of the household during the accounting period, converted to figures for a whole year by multiplying with 26, plus the housing expenses and consumer durable purchases recorded in the interview. Income is added from tax records. The SCE contain non-response weights by household type, and all descriptive statistics below are computed using these weights.

We cannot link the respondents in the Survey of Consumer Expenditures directly to our imputed consumption measure with their personal identification number, as the respondent would need to give their approval of such use. Instead, we compare the distributions of the consumption measures and compare measures based on characteristics of the household. Since the survey sample is limited in size we must choose rather broad comparison groups.⁹

Figure 8. Comparisons of consumption by age group



Note: Mean consumption in the Survey of Consumer Expenditures (SCE) and imputed consumption from registry data in 2000 (left) and in 2007 (right), in NOK.

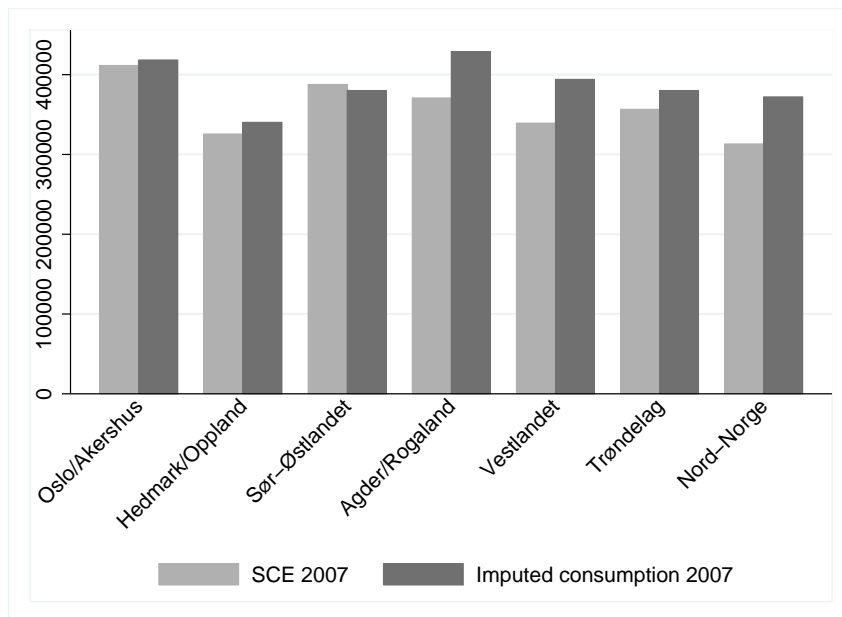
Figure 8 compares the average consumer expenditures by age group in the survey with our imputed consumption measure in two selected years, 2000 and 2007. In 2000 the two measures are quite similar, in particular for the middle-aged age groups. The imputed consumption measures are lower than the survey measures for younger households and higher than the survey measures for the eldest households. This is in line with the findings of Koijen et al. (2014) who found that the elderly are more likely

⁹Koijen et al. (2014) find that even though the mean and median of spending are similar in the survey data and in their imputed measure, the correlation at the household level is weak. Carroll et al. (2014) question whether this means that the Swedish expenditure surveys are especially poor or whether this suggests a more general flaw of the registry imputation method. Unfortunately we cannot investigate this further on the Norwegian data.

to under-report large purchases such as e.g. that of a car in consumer expenditure surveys. Furthermore, the survey means are based on very few observations for high ages, for instance in the 2000-survey there are 70 observations of households with respondents aged 60 to 66, and 84 observations of households with respondents aged 67 and older.

In 2007, the imputed consumption measure is higher than the survey measures, while in 2000 they are about equal. A possible reason for this is that the problem of under reporting in consumer surveys is growing over time. According to Pistaferri (2015), there is an increasing divergence over time between average consumption measured by consumer surveys and national aggregates in the US. In Section 7.6 we discuss alternative definitions of consumption and show that the level of our preferred measure is higher than the SCE level and lower than the average level in the National Accounts, but that it follows the same time trend as the average in the National Accounts.

Figure 9. Comparisons of consumption by region



Note: Mean consumption in the Survey of Consumer Expenditures (SCE) and imputed consumption from registry data in 2007, in NOK.

In addition, we also look at differences between regions of Norway (we expect consumption levels to be higher in the big cities than in more remote parts of the country). According to Figure 9, the imputed consumption measures and the survey measures both show the expected variation with lower consumption in more rural areas (Nord-Norge and Hedmark/Oppland) and higher consumption in more urban areas (Oslo/Akershus and in the oil-industry dominated Agder/Rogaland-region in

South-Western Norway).

Table 1. Distribution of consumption measures. Year 2000

	SCE	Imputed		SCE	Imputed
1%	38	28	Mean	284	258
5%	73	74	Std. dev.	192	199
25%	158	134	Minimum	3	0.001
50%	238	210	Maximum	1,880	12,200
75%	368	323			
95%	656	587	Gini-coefficient	.345	.353
99%	872	1,064	No of observations	1,048	343,193

Note: All amounts are in thousand NOK.

Finally, Table 1 presents a more detailed comparison with respect to the overall distribution of the two consumption measures. It highlights how the imputed consumption from registry data may generate more observations of very low and very high consumption, but otherwise the distributions are similar. Although we have selected one year in Table 1, the same relative distributional properties are present in all years.

6.2 Inequality

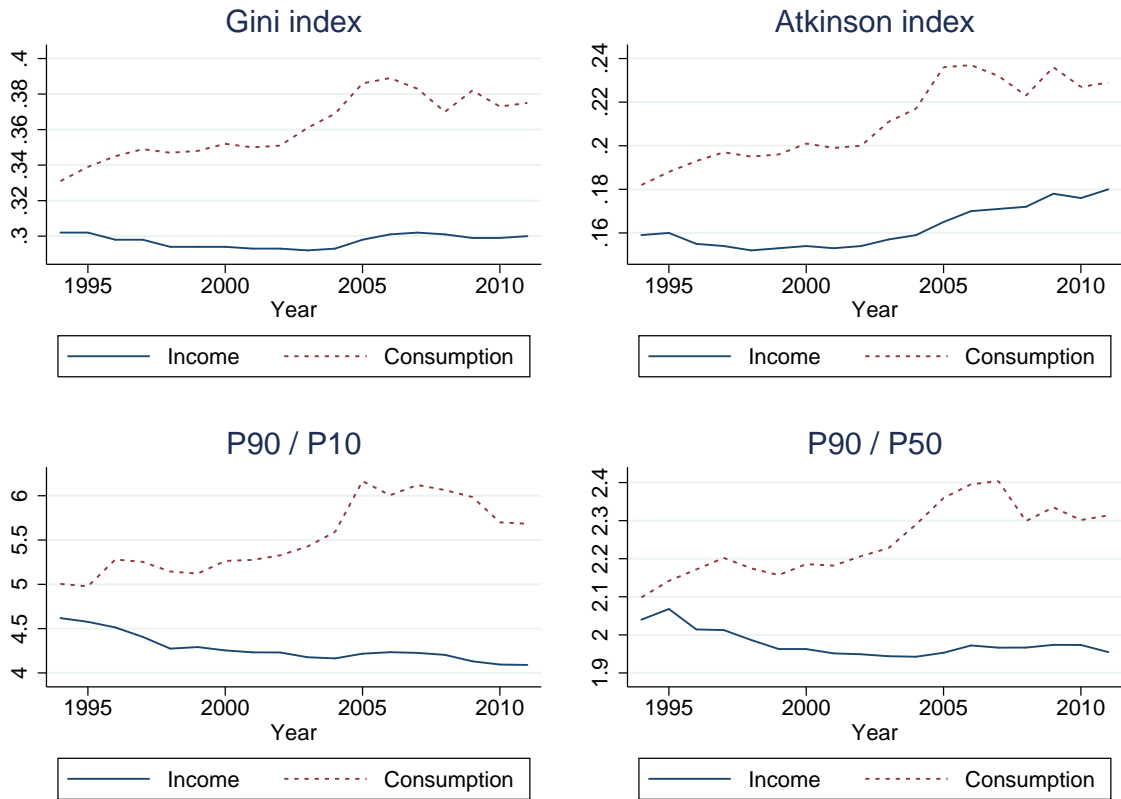
In an influential paper by Krueger and Perri (2006) it was found that the rise in US income inequality has not translated into a similar increase in consumption inequality. This result has been used by some to argue that increases in income inequality is a smaller problem than it appears, as households' standard of living is more directly determined by their level of consumption rather than their level of income. Aguiar and Bilal (2015) argue that Krueger and Perri's result is mainly driven by the fact that consumption inequality measured on the basis of consumer expenditure surveys is consistently low and stable. Using an alternative measure of consumption, imputing consumption as income minus savings, they find instead an increase in consumption inequality similar in magnitude to the change in income inequality. They also find higher level of consumption inequality when using the budget constraint definition than when using the survey data for consumption. Using a variety of data sources and controlling for measurement error, Attanasio et al. (2014) reach the same result.

Figure 10 shows the calculation of consumption and income inequality based on our data. Overall, since we have richer and noisier savings data, the inequality in consumption turns out even higher than in income after tax.¹⁰ However, it is the

¹⁰Income is here defined as in the official Norwegian income statistics, but subject to the same

development over time that is of most interest. According to our data, there was an increase in consumption inequality from 1995 to 2005, while income inequality in the same period was either stable or slightly declining (only the Atkinson index exhibits a small increase in income inequality in the same period). This is in line with the growth rates in Figure 7 that showed faster consumption growth at the top of the income distribution prior to the recession. After the financial crisis, which affected high-income households most, the difference in consumption inequality seems to have stabilized. Similar evidence of substantial slowing down of consumption inequality during the financial crisis has been observed on US data (see Pistaferri et al. (2012)).

Figure 10. Income and consumption inequality



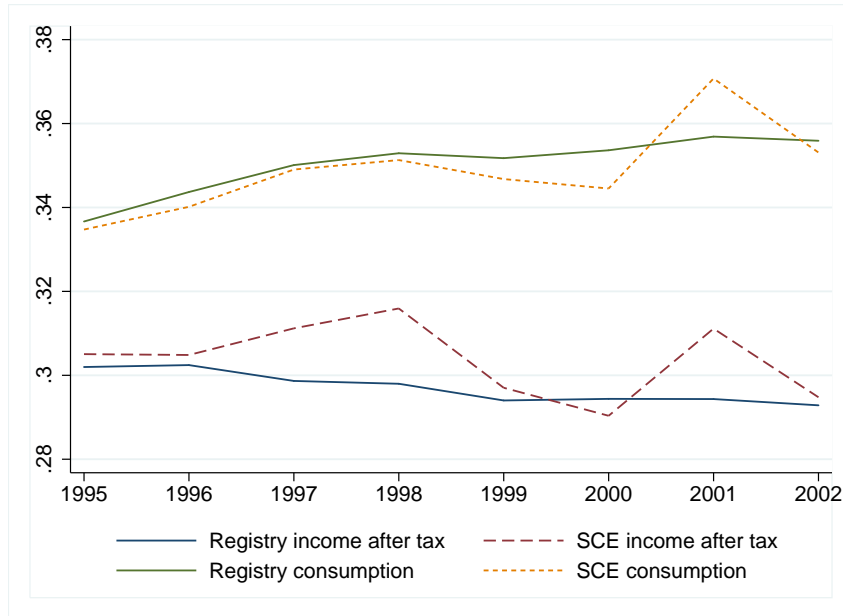
Note: Consumption inequality and income inequality based on the definition of income after tax as in official statistics from Statistics Norway. 1994-2011

We have attempted to run the inequality analysis without the top-wealth exclusions, but found that it increases the volatility of all measures in Figure 10, and to such a degree that it is no longer possible to detect a trend over time. Furthermore, the extreme dividends paid out prior to the 2006 tax reform complicate interpretation of results. It is not obvious that a consumption measure that is dominated

exclusions of households as for the consumption measure in order to make the series comparable.

by very large movements in financial assets by a select group of extremely wealthy households is a better measure than one that includes some, but not all, of the wealthiest households (see the discussion in Section 5) and that has reasonable properties across households, over time, and in comparison with alternative data sources.

Figure 11. Income and consumption inequality in the SCE and the registry data



Note: The figure show Gini coefficients for income after tax (i.e. the standard definition in Statistics Norway's income statistics) and consumption as measured in the Survey of Consumer Expenditures (SCE) and in the registry data. 1995-2002.

Another interesting comparison is to contrast consumption and income inequality in the registry data with consumption and income inequality in the Survey of Consumer Expenditures. Figure 11 shows that for Norway, the argument that consumption inequality measured on the basis of consumer expenditure surveys is too low and too stable is not relevant since both the consumer survey data and the registry data show the same development over time, except that the survey data is more volatile, something that is most likely due to the small sample size.

These results imply that since the surveys are now infrequent and far apart, the registry data method for imputing consumption may be representative in for instance analysis of consumption and income inequality over time.

7 Detailed data description and sample restrictions

The construction of an empirical measure of consumption expenditure for households from administrative records has formidable requirements. Ideally, in addition to complete records of income and transfers over the period one needs data on households' complete portfolio holdings over a long time span, free of measurement and reporting errors. The Norwegian tax registry data that we use in our empirical analysis come close to meet these requirements. In this section we discuss the data sources used, limitations of these, and the sample restrictions we impose to mitigate the potential measurement error in our imputation method.

7.1 *The Data*

Administrative Tax records Because households in Norway are subject to a wealth tax, they are required to report every year their complete wealth holdings to the tax authority, and the data are available every year from 1993 up until present time.¹¹ Every year, before taxes are filed (in April the year after), employers, banks, brokers, insurance companies and any other financial intermediaries are obliged to send both to the individual and to the tax authority, information on the value of the asset owned by the individual and administered by the employer or the intermediary, as well as information on the income earned on these assets. For an individual holds no stocks, the tax authority pre-fills a tax form and sends it to the individual for approval; if the individual does not respond, the tax authority considers the information it has gathered as approved. In 2009, nearly 2 million individuals (60 percent of the Norwegian tax payers) belonged to this category. If the individual or household owns stocks then he has to fill in the tax statement - including calculations of capital gains/losses and deduction claims. The statement is sent back to the tax authority which, as in the previous case receives all the basic information from employers and intermediaries and can thus check its truthfulness and correctness. Stockholders are treated differently because the government wants to save on the time necessary to fill in more complex tax statements. This procedure, particularly the fact that financial institutions supply information on their customer's financial assets directly to the tax authority, makes tax evasion very difficult, and thus non-reporting or under-reporting of assets holdings are likely to be negligible.

¹¹In Norway the individuals in a household are taxed jointly for the wealth tax, and separately for the income tax. For further information on the institutional details or the following description see Fagereng et al. (2015).

FD-trygd events database Importantly, the administrative tax records contains unique personal identification numbers which enable us to merge tax records with other data sets. We merge our tax data with important variables from the FD-trygd events database of Statistics Norway. The dataset includes detailed information on household family identifiers enabling us to build data at the household level, and to identify who has family relations within (marriage, cohabitation) and between generations (parent-children information).¹² From these data we can also deduct information on family size and composition. The dataset also contains information on household education (level and type).

Stock ownership registry Kojien et al. (2014) exploit in the Swedish data the ability to calculate household-specific portfolio return to assess the consequences of ignoring capital gain or losses. This relies on the ability of the researcher to observe the exact asset composition of each households portfolio at the end of each year. For the year 2004-2011 we observe the exact asset composition at the single stock levels for stocks traded at Oslo Stock Exchange. This allows us to make a more precise measurement of the active savings of the households for this period.¹³

Other sources To further complement these data we include information (via the unique personal identification number) from the register of income and transfers, and inheritance and gift register to identify large transfers between individuals between and within families.¹⁴

Housing values Income from housing in the income tax base was abolished in 2005 in Norway. However, the imputed income was based on tax values for housing that had a weak relation to actual market prices. The same tax values were used as a basis for the wealth tax. Tax values for housing for the period 1993-2009 were on average about 20 percent of market prices. Individual variation was primarily linked to the construction year of the house. Old, refurbished villas in attractive neighborhoods could in some cases have tax values close to zero. Furthermore, the tax values were adjusted irregularly. As a result, the tax values were not useful as

¹²A couple (or a household in this context) is identified as two individuals who are married, or as two individuals who live together with common children. Unfortunately it is not possible to identify unmarried but cohabiting couples without children.

¹³We thank Bernt Arne Ødegård for providing us with ISIN-codes and end of period prices. For further information on the empirics of the Norwegian Stock Exchange see Ødegaard (2015)

¹⁴Halvorsen and Johansson (2015) has found that estates in the inheritance register undervalued actual wealth transferred by a factor of 0.52 in the period 1998-2010. This was found to be partly due to rich families' tax planning in the late stages of life and partly due to very low assessments of housing wealth in the estate filings.

approximations of actual housing values. However, imputations of housing values based on hedonic price regressions are available from 2005 (see Thomassen and Melby 2009; Kostøl and Holiløkk 2010 and subsequent annual reports). From 2010 these values were also implemented as basis for wealth taxation in the tax records (that is, the tax value is set to 25 percent of the imputed market value). In the imputation of consumption we define one measure using these data from 2005 to 2011. To mitigate potential measurement errors in household assets we exclude year observations of households that have reported relocation to the address register, since this is likely to be years in which the household has traded housing (where we observe fully the change in mortgage, but not the corresponding purchase or selling price).

The housing stock also depreciates over time, but unlike cars and household durables, it never deteriorates completely. Instead, it is common to undertake infrequent major refurbishment in order to get the housing stock up to modern standards. This lumping of maintenance costs, often financed by remortgaging, represents a measurement problem in our data since the market value does not represent the exact individual housing value. Market housing values, when available, are based on housing attributes such as location, type, size and age.

Holiday homes, on the other hand, are still reported with tax values that are far below actual market values. This is why we also choose to exclude year observations of households who purchase holiday homes.

Valuation of Financial Assets As noted above, the information on the detailed household portfolio composition is collected each year by the tax authorities to levy the wealth tax. The information is collected for all households even though only a small fraction is liable for the wealth tax. The data includes also smaller deposit accounts, which in other countries such as Sweden are censored for lower amounts, see Calvet et al. (2007).

The tax valuation of stocks, bonds and mutual funds were subject to different rules over the period 1993-2007, varying between 30 and 85 percent of the market values. As a first step we adjust all financial asset categories so that they represent market value, and not their tax values. Hence, obtaining a precise measure is unproblematic for most of the financial portfolio. The valuation of listed stocks is straightforward because they are all registered in the Norwegian Central Securities Depository (VPS). The valuations of non-listed stocks however is more problematic since these are based on accounting principles and is likely biased downwards. In our sample about 6 percent of the households in any period hold this asset class. Since

this measurement issue will create unnecessary noise in our consumption measure we drop households holding this asset type in the current or previous year. How this reduces the standard errors of consumption measures is discussed in Section 5.

Pension rights through the state pension plan or occupational pension schemes are not subject to taxation through the wealth tax and is therefore not reported in the tax registry. It is possible to set aside savings in tax-exempt individual pension savings (IPS). However, the benefits from the IPS are so small that it is rarely used, only 1 percent of Norwegian households save in IPS (4 percent of households close to retirement), the amounts invested are small and the tax treatment have varied over time. The same applies to the cash value of life insurance, another asset category that is insignificant in the Norwegian context. Because of the differential tax treatment over time and their modest part of Norwegians asset portfolio, we exclude individual pension savings and cash value of life insurance from the savings definition.

7.2 *Active and passive savings*

For our full time period from 1993 to 2011 the variables we observe and define in the data are broad asset classes of bank deposits, bonds, mutual funds and stocks. In our measure of bank deposits we have also included cash holdings (cash holdings are one of the few remaining self reported categories, and commonly ignored by the tax files). In the bond variable we also include money market funds. Overall bank deposits and bonds constitute our “safe” assets. Mutual funds are a category of investment assets which became increasingly available to the Norwegian public during the later 1990s. It allowed exposure to stock ownership without directly holding stocks. Before imputing the return from a given asset class, we deflate all of the above asset classes with the CPI-index. Finally we take the historical annual return of Oslo Stock Exchange to calculate the returns of stocks. We make use of a weighted Oslo Stock Exchange (30%) and MSCI World index (70%) to impute the returns of mutual fund returns, and we use the Treasury bill to impute returns on bonds. Other financial assets are represented by deflated differences only. The active savings in each financial asset class is then defined as

$$\begin{aligned}\Delta D_{it} &= D_{it} - D_{it-1} \\ \Delta A_{it} &= A_{it} - \frac{P_{it}^a}{P_{it-1}^a} A_{it-1} = A_{it} - R_{it}^a A_{it-1}\end{aligned}$$

where D is debt, A is financial assets, and R^a is the imputed returns. For the entire period we observe only broader asset classes, and we have to make some assumptions

on general returns for the different risky asset classes. For the period 2004-2011 of our sample we do as Koijsen et al. (2014) observe the complete detail of the household portfolio at the asset level in our data and we use this in the imputation in an alternative consumption measure, see Section 7.6. Hence, for the period 2005-2011 we are able to calculate active savings using also this information.¹⁵

Active saving in real assets is mainly depreciation of or new investment in vehicles and changes in other real assets (note however that we have left out owners of production capital and transactions of holiday houses). Alternatively, as in Koijsen et al. (2014), the same procedure of removing assets returns could in practice be applied to owner occupied housing, which would be a measure of active investment in housing wealth (up sizing/downsizing). Because of the incoherent housing value data for the period prior to the year 2010, we have chosen not to include housing investment in our consumption measure.

7.3 Imputed income from owner-occupied housing

The calculation of income from housing is a measurement issue that often attracts concern, see e.g. Frick et al. (2007). We therefore briefly explain the methods that are commonly used to impute income from owner-occupied housing. There are three main approaches: rental equivalence, user-cost or capital market approach, and out-of-pocket expenses. The latter demands observations of the actual outlays on housing, which is usually found in consumer expenditure surveys. Since this is not the kind of data that we have, the two relevant approaches are the rental equivalence method and the user-cost, or capital market, approach. The rental equivalence method is based on regression models that have rent as the dependent variable and housing characteristics as the right hand side variables. As Røed Larsen and Sommervoll (2009) has shown, the number of square meters and area of residence are the two most important characteristics, so that a rough measure of imputed rent can be obtained on the basis of these two variables alone.

The user cost associated with home-ownership is the sum of forgone interest income, property taxes, a risk premium for housing investments, maintenance and depreciation costs, less the owner's nominal capital gain. Since, in equilibrium, the user cost of housing should equal the income from housing, the user cost can thus be taken as a measure of imputed income from housing. However, unless one has information about actual maintenance and depreciation costs and so on, there are

¹⁵We observe stock holding in companies listed at the Oslo Stock Exchange every year. This enables us to more precisely calculate the active savings by observing the number of stocks held in each company.

many parameters that are needed in order to impute values.

The capital market approach is based on the same type of reasoning, but is simpler to employ. The starting point is the alternative use of capital in the capital market. Application of the capital market approach is often founded on the current market value of owner-occupied housing and outstanding mortgages, which needs to be deducted from the estimated market value. The implicit rate of return will equal a safe market rate of return on an equal value of investment. Instead of applying a nominal interest rate to total net home value, the nominal interest rate may be applied to the outstanding mortgage (in our data the actual nominal interest paid is directly measured but we cannot separate mortgages from other debt), while the calculation of the return on investment in housing needs to consider that inflation is included in the nominal house value appreciation. Then it may be more appropriate to apply a real interest rate to the dwelling's current market value. A problem with this approach is that it does not take into account any potential depreciation of the building.

Here, income from housing is based on the capital market approach that calculates the potential return of the house value investment. Using a Norwegian historical price index (Eitrheim and Erlandsen, 2004), we compute the long run nominal return to housing wealth to be around 5 percent. This is the median value of all long run averages ranging between 1913-2013 and 1993-2013.¹⁶ The average inflation rate in our sample period is 2 percent, yielding a long run real rate of return to housing of 3 percent. This corresponds both to values used internationally (Frick et al., 2010), and to the average real pretax return to bonds in the same period.

Theoretically, this should equal an estimated value of imputed rent. Imputed rent should be comparable to the payment for housing services, such as maintenance and repairs, property taxes, and mortgage interest. Comparisons of the imputed income from housing and the level of reported out-of-pocket expenses on housing (or rent in the case of tenants) reported in the Survey of Consumer Expenditures corresponds quite well (not shown), suggesting that including imputed income from housing may capture well housing related consumption.

7.4 *Durables*

We will consider two alternatives. One is to treat all durables as consumed in the year of purchase (as in the National Accounts). The other is to include in the consumption measure the depreciation of cars, boats and other motor vehicles. Cars,

¹⁶The price index has been maintained even after the publication of Eitrheim and Erlandsen (2004).

boats and other motor vehicles are reported in the tax record with standardized list values depending on brand and year of production. The list value in the first year after purchase is about 75 percent of the market value, thereafter most list values decline on average 10 percent each year. Where the depreciation is not already given by declining tax values, we compute an annual depreciation rate of 10 percent. Previous (and more thorough) attempts at deriving the user cost or rental equivalent of durables on Norwegian data are reported in Biørn and Jensen (1983) and Magnussen (1990).

7.5 *Sample selection*

For computational reasons we start out with a 20% random sample of the population for the period 1993-2011 and track individuals for as long as we observe them in our data. For these randomly selected individuals we merge spousal information for the years the individual is either married or in cohabitation. We keep all types of households but limit the age of the household head downward to 25 and upward to 90. That gives us a total of 10,320,392 household-year observations. As the imputed measures of consumption are obtained by differencing we take the following steps to select our sample, closely following Browning and Leth-Petersen (2003) and Koijen et al. (2014).

Table 2. Sample selection

	Restriction	Observations
0	Initial 20% population sample, household heads aged 25-90	10,320,392
1	Excluding observations of change in the number of adults in the household	8,795,654
2	Excluding observations of real estate transactions (owner occupied and holiday homes)	7,907,669
3	Excluding households with non-listed stocks, dividends above 1G and extreme returns	6,979,335
4	Excluding business owners and production capital owners	6,262,631
5	Excluding imputed negative consumption	6,047,166

First, we remove households who do not have a stable composition from one year to the next. This includes dropping households where the number of adults either increase or decrease. This step removes 1,524,739 observations. Secondly, we exclude year observations of homeowner households that have reported a change of address to the address registry. Since we do not have information about the exact

prices involved in the house transaction (only imputed housing values used for tax purposes), but do observe the exact change in mortgages, it is likely that these transactions are causing large fluctuations in asset holdings not necessarily related to our consumption measure. Similarly, we exclude year-observations of transaction of holiday homes. This step removes 887,985 observations.

Third, we remove households who experience extreme financial asset gains, receive large dividends or who hold non-listed stocks. Under the Norwegian 2006 tax reform, dividends became taxed at both the corporate and individual levels, in contrast to the 1992 reform which had only corporate level taxation. The introduction of a tax on dividends caused major income shifting in the years prior to 2006. This income shifting reflects a general problem with dividends as a measure of business income, i.e. that it is only observed when realized or distributed, and that realization tends to be lumpy. Alternative measurement have been suggested by Fjærli and Aaberge (1999) who use imputed total returns to shares, and by Thoresen et al. (2012) who use business income imputed as firm profits attributed to owners. Here, we do not impute business income, but instead exclude dividends above the basic amount threshold of the Norwegian Social Insurance Scheme, which is adjusted every year according to inflation in prices and wages and in 2011 amounted to about 11,300 USD. To mitigate the problem of measurement error we also exclude households with extreme returns, defined as calculated financial asset change in the top 1% or lower 1% tail of the distribution within a year. Lastly in this step we follow Koijen et al. (2014) and drop households holding non-listed stocks due to valuation problems as commented on in the previous subsection.

Fourth, we exclude business owners with income from own business of more than the basic amount of the Social Insurance Scheme. For our purpose of imputing consumption it is hard to separate personal and business expenditures (Alstadsæter et al., 2013). Of the same reason we also exclude households with production capital. The last restriction, excluding business and/or production capital owners was motivated by the fact that it is difficult to separate private consumption from business consumption. This is necessary if the main goal is to obtain a good measure of household consumption. By itself, this group does not contribute all that much to the volatility of the consumption measure, but introducing business in sample will increase overall inequality as they contribute to somewhat higher incomes in the top part and somewhat lower incomes (since this group may report negative incomes) in the bottom part of the income distribution. Finally, we require that the imputed consumption measure must be non-negative.

These exclusions are summarized in Table 2, and our sample is now reduced

to a little more than 6 million observations, or 60 percent of the original sample (comparable to the reductions due to sample selection in Koijen et al. (2014)). How each step affects the distribution is shown in more detail in Table 3.

Table 3. Consumption by sample selection. Year 2007

	Consumption = disposable income - active financial saving					
	0	1	2	3	4	5
Mean	439,218	420,142	397,221	379,636	367,340	393,867
St. dev.	6,908,140	6,847,451	7,000,924	390,060	367,572	300,035
p5	-121,908	-75,523	-10,758	41,547	52,897	101,762
p25	178,284	176,568	179,199	179,487	177,421	188,143
p50	323,866	314,424	313,814	302,898	293,885	304,520
p75	562,126	541,914	523,968	495,889	481,057	489,846
p95	1,597,079	1,470,810	1,214,005	994,364	938,111	951,549
# of obs.	562,636	499,942	449,393	403,036	363,573	350,827

0 = Initial 20% population sample, household heads aged 25-90
1 = Excl. observations of change in the number of adults in the household
2 = Excl. observations of real estate transactions (owner occupied and holiday homes)
3 = Excl. households with non-listed stocks, dividends above 1G and extreme returns
4 = Excl. business owners and production capital owners
5 = Excl. imputed negative consumption

We note the importance of the different sample selection restrictions. Excluding households with extreme financial returns reduces the standard deviation of our sample quite significantly, whereas we also see how the other restrictions help in removing households with e.g. negative imputed consumption, which can easily occur if the household has sold and bought a house, or its composition has changed recently.

Basing the measure of consumption on changes in net worth makes the measure vulnerable for dramatic changes in net worth that may be caused by changes that are not observable to us, and that are not identified by the restrictions listed in Table 2. All analyses that use this measure of imputed consumption apply in addition some rule for handling extreme outliers. Koijen et al. (2014) chooses to exclude households if the change in net worth is in the bottom 2.5 or in the top 2.5 percent of the corresponding year-specific distribution. Kniesner and Ziliak (2002) delete person years with more than 300-percent increase or more than a 75-percent decrease in consumption.

We have chosen the rule of excluding households if the change in financial active saving is in the bottom 1 or in the top 1 percent of the corresponding year-specific distribution, plus if imputed consumption is negative (which is essentially the restriction that active saving cannot exceed disposable income). The difference

between our choice of handling extreme observations and excluding the top/bottom 2.5 percent of wealth changes is not very large. Since the savings distribution is skewed to the left, mean savings increase and mean consumption decrease as we cut off more and more of the heavy negative tail. The choice of Kniesner and Ziliak (2002) drives the mean and median up instead of down compared to trimming the distribution, and causes the largest change compared to our base exclusions.

7.6 *Alternative definitions of consumption*

Based on the data available we use two income concepts; one is disposable income defined as labor income plus transfers plus net capital income plus gifts and inheritances minus taxes, and the other is disposable income defined as before but including also imputed income from housing. Theoretically, this is a superior income definition but because we lack complete housing values over the whole sample period, we are only able to compute this measure for the period 2005-2011. The base definition of consumption (C1) is disposable income less active financial savings, where active financial saving is the first difference in net financial assets adjusted for asset returns and revaluations.

For comparison we check our base definition against three alternative definitions. Consumption measure C2 is defined as disposable income minus total active savings, i.e. including depreciation of durables in the consumption definition. Consumption measure C3 applies the single stock holding data to calculate the active savings in stocks more precisely, which we are able to observe since 2004 - and hence are able to impute active financial saving starting from 2005. Finally, consumption measure C4 applies the augmented income definition that includes imputed income from housing. This measure is also only available from 2005.

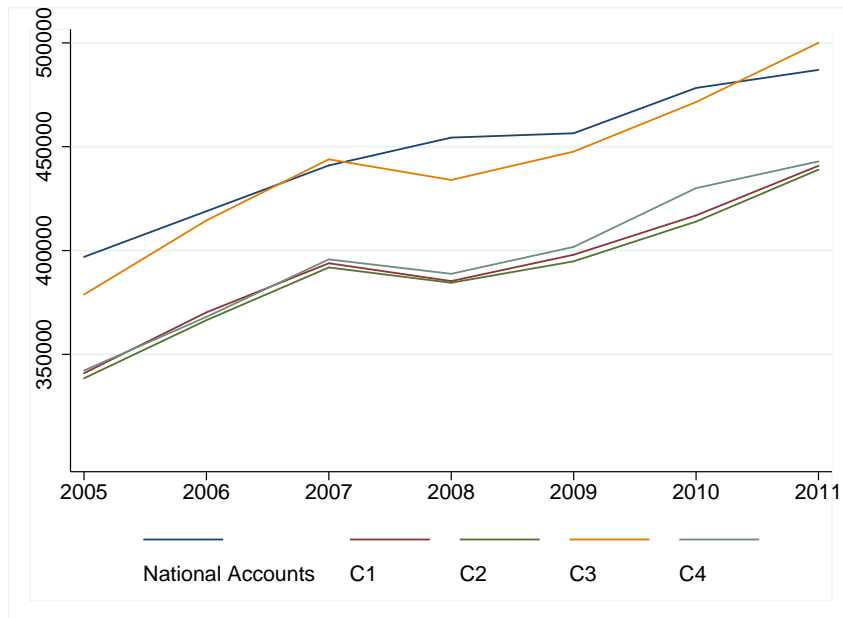
Table 4. Alternative consumption definitions. Year 2007

	C1	C2	C3	C4	SCE	NA
Mean	393,867	395,737	391,851	443,928	344,517	440,987
Median	304,519	306,722	304,250	355,721	–	–
Std.dev	300,035	311,099	298,933	300,857	–	–
C1 = Disposable income - financial active saving						
C2 = Disposable income - active saving (real and financial)						
C3 = Disposable income - financial active saving adjusted for gains on single stocks						
C4 = Disposable income + imputed income from housing - financial active saving						
SCE = Survey of Consumer Expenditures						
NA = Total household consumption divided by total number of households						

Table 2 displays means and medians of the different consumption measures for

a year in which we are able to calculate all alternatives, 2007, plus corresponding figures from the Survey of Consumer Expenditures and the National Accounts. The measure that applies the single stock holding data to calculate the active savings in stocks more precisely yields slightly lower mean and median consumption, while the measure that includes depreciation of durables in the consumption definition yields slightly higher mean and median consumption compared to the base definition. Using single stock holding data to calculate the active savings in stocks lowers the imputed consumption measures in the top and bottom of the distribution (yields a larger share of imputed negative consumption), and the standard deviation pre-exclusions increases. The median is little affected (as the median do not hold stocks), and

Figure 12. Alternative consumption definitions, 2005-2011



Note: The figure plots annual consumption over the period 2005-2011 as measured in National Accounts and four measures of imputed consumption from registry data, defined as follows:

- C1 = Disposable income - financial active saving,
- C2 = Disposable income - active saving (real and financial),
- C3 = Disposable income - financial active saving adjusted for gains on single stocks,
- C4 = Disposable income + imputed income from housing - financial active saving.

overall after exclusions the mean is also quite similar. Since this method is not straightforward with respect to choosing the relevant timing of gains, and since it reduces the data period, we prefer the base definition. Including depreciation of durables in the consumption definition is preferable to not including depreciation. However, the small difference between the two consumption measures indicates that simply using the change in tax values only measures a fraction of durable depreciation. Thus, we prefer the definition of active savings as financial saving

instead of employing only a halfway definition of active saving that includes both financial and real saving.

Finally, we see that the measure including income from housing yields a considerably higher consumption measure. Whether this brings us closer to the “true” level of consumption is an open question. Included in the table are the average values for consumer expenditures from the Survey of Consumer Expenditures in 2007, and the average consumption obtained by dividing aggregate consumption in the National Accounts with the number of households in 2007. Our base measure of consumption, C1, lies in-between these two estimates. Figure 12 shows that the measure including income from housing tracks the average level constructed with National Accounts data best. The other three measures are similar over time, and at a lower level than the National Accounts and the measure including income from housing. However, the overall time trend is the same for all measures, and ultimately the choice of definition will depend on the problem one wishes to address.

8 Conclusion

This paper has documented a method for imputing a longitudinal measure of consumption for the entire Norwegian population for sample period of almost 20 years, applying reliable data from administrative records collected for tax purposes. Imputing consumption from register data proves to be a useful addition to measuring total household consumption based on ordinary consumer expenditure surveys.

Expenditure surveys have a number of drawbacks: recall error for durables and other infrequent expenditures, attrition, under representation of wealthy families, and under reporting of spending. Furthermore, there has been a general deterioration in survey response rates in many countries. Register data does not have such limitations and offers a potentially much larger sample with better coverage of all household types. This is particularly useful for studying heterogeneity in consumption behavior, for distributional analysis, and for analyses that require long panel data on consumption.

There are both advantages and drawbacks to using imputed consumption from registry data. One advantage is that there is no attrition and a large coverage of households, something that is essential for measuring heterogeneity in consumption behavior and for distributional analysis. Another is that it provides long panel data, something that most expenditure surveys do not. The drawbacks are that it is not possible to separate between consumption categories, most importantly between durables and non-durables. Another is that because of measurement errors in income and wealth, some of the wealthiest households must be excluded in order to obtain

sensible measures of consumption. One of these measurement issues concern the correct measurement of business income. Another measurement error particular to the Norwegian registry data is the inadequate measures of housing wealth. Future work that improves on the measurement of business income and house values will greatly benefit the method for imputing consumption from registry data.

However, compared to consumer expenditure surveys that lack information on certain households, register data retain the possibility of including the very wealthy. In this paper we have presented a set of data modifications and sample restrictions that we believe are sensible give the objective of providing consumption data that are useful for different important research and policy topics. Other choices are possible, and depending on the analysis of interest, other choices may be required. Actually, the possibility for variations of the measure makes the method flexible and can be applied in many different analyses of consumption and saving, poverty and inequality, and risk sharing and insurance.

Further, combining these data with information on unemployment and employer-employee registers will allow for promising future research on household consumption in relation to economic uncertainty. The data set can be used to study consumption elasticities between various socio-economic groups, and one can get a valuable picture of household vulnerability and responsiveness to changes in economic conditions like house prices or interest rates.

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